Accessory Head of Biceps Brachii Muscle: Anatomy, Histology, and MRI in Cadavers

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OBJECTIVE. The purpose of our study is to describe and define an anatomic variation located close to the bicipital groove using MRI with gross anatomic and histologic correlation in cadavers.

MATERIALS AND METHODS. Ten fresh male human shoulders were harvested and used in this investigation. They were derived from persons with a mean age of death of 78.9 years (age range, 58–92 years). MR arthrography using proton density–weighted sequences was used to obtain images in axial, coronal, and sagittal planes. After imaging, the specimens were cut in axial, coronal, and sagittal sections using a band saw. The slices were then photographed to allow correlation with the MR arthrographic images, followed by histologic analysis.

RESULTS. Two anomalous tendons, both intimate with the tendon of the long head of the biceps brachii muscle in the bicipital groove, were recognized. The origin of both tendons was in the greater tuberosity near the articular capsule. These structures had a muscular belly that was joined with the other biceps bellies. At the level of the bicipital groove, the anomalous tendons appeared as hypointense structures in proton density–weighted images, with a mostly flat morphology in axial and coronal planes. The average dimensions of these structures were 45.5 (craniocaudal) × 6.2 (anteroposterior) × 0.85 (mediolateral) mm.

CONCLUSION. The MR images, gross anatomic inspection, and histologic information led us to conclude that these anomalous structures were accessory heads of the biceps brachii muscle.

Keywords: accessory head of the biceps brachii muscle, anatomy, MRI, shoulder

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Anomalous muscles are one of the more frequent anatomic variations around the shoulder. Familiarity with these structures is important not only because of the clinical symptoms that they can cause by compressing the adjacent neurovascular bundles but also for correct identification at the time of imaging or surgery [1]. Some anomalies that are located in the anterior aspect of the shoulder include accessory heads of the biceps brachii muscle, coracobrachialis brevis muscle, accessory subscapularis muscle, and aberrant muscle bundle originating from the latissimus dorsi or pectoralis major and minor muscles [1, 2].

During the routine evaluation of some MRI studies of the shoulder, a small hypointense structure in T1-, T2-, and proton density–weighted images that is mostly flat in the axial plane and linear in the coronal plane is sometimes observed close to the bicipital tendon, within the bicipital groove. To the best of our knowledge, this structure, which can easily be misinterpreted as evidence of partial tearing of the biceps tendon, has not been described in MRI and anatomic investigations. Thus, we initiated a study designed to evaluate the nature of this finding using close MRI–anatomic correlation in cadavers.

Materials and Methods

Ten fresh human shoulders, including the entire arm, were harvested from five unembalmed male cadavers (age range, 58–92 years; mean age, 78.9 years). The cadaveric specimens were immediately stored at −41°C in a freezer (Forma Bio-Freezer, Forma Scientific) and were allowed to thaw at room temperature for 12 hours before MRI. MR images were obtained with a 1.5-T scanner (Signa, GE Healthcare) with a superficial flexible coil to allow better definition of the bicipital groove. In the first specimen, both T1- and photon density–weighted spin-echo sequences were tested to select the better sequence based on contrast enhancement and resolution of the tissues.

Both routine MRI and MR arthrography were performed in all specimens. A total of 15 mL of

contrast material was injected in each specimen to fully distend the joint and therefore better assess the relationship between any anomalous structure and the joint. The images were acquired in the axial, sagittal, and coronal planes, with the arm in the neutral position, using the following protocol: proton density–weighted spin-echo with fat saturation (TR/TE, 3,000/28; section thickness, 2 mm; no interslice spacing; number of signals acquired, 2; field of view, 12 × 12 cm; and matrix, 512 × 256 pixels) and proton density–weighted spin-echo (2,800/15; section thickness, 2.2 mm; 0.2-mm interslice spacing; number of signals acquired, 2; field of view, 7 × 7 cm; and matrix, 512 × 256 pixels), unenhanced and contrast-enhanced, respectively.

Two musculoskeletal radiologists performed arthrographic injection of the glenohumeral joint under fluoroscopic guidance. A 21-gauge needle was used from a dorsal approach. A dilute gadopentetate solution was prepared with a mixture of 2 mL of gadolinium dimeglumine (Magnevist, Bayer HealthCare) and 250 mL of saline (50%) and iodinated contrast agent (50%) (iohexol, Omnipaque 350, GE Healthcare). A total dose of 20 mL was injected into the articulation.

After MRI was complete, the cadaveric specimens were frozen again at −41°C for more than 72 hours and were subsequently cut with a band saw into 3-mm-thick slices so that anatomic slices corresponded closely to the MRI planes. The anatomic slices were cleaned with running water for macroscopic inspection. Each slice was recorded photographically and imaged.

Histologic analysis of two specimens in the axial plane was performed. The tissue was fixed in 10% neutral buffered formalin for at least 72 hours, and excised specimens were embedded in paraffin wax. Slices with a thickness of 5 μm were obtained by using a microtome and were mounted, stained with H and E, and examined with a light microscope by an experienced pathologist.

Results

In two of the 10 specimens, an abnormal structure was identified close to the bicipital groove. In both cadavers, this structure seemed to originate from the greater tuberosity close to the articular capsule, ran parallel to the bicipital groove, and joined the other muscle heads of the biceps brachii at the level of the humerus midshaft. This anomalous structure lay superficial to the biceps tendon as the latter passed through the bicipital groove (Fig. 1).

In the bicipital groove, the anomalous structure appeared as a small hypointense focus in proton density–weighted spin-echo images (Fig. 2). In the axial plane, it

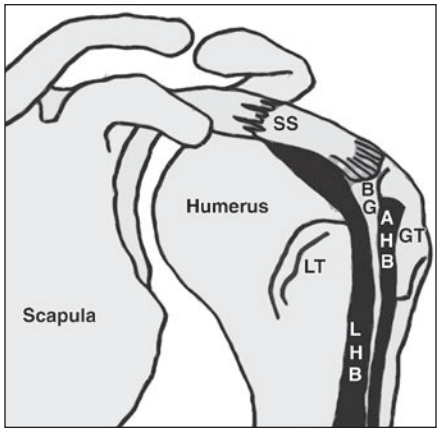


Fig. 1—Drawing shows frontal view of shoulder. AHB = accessory head of biceps brachii, LHB = long head of biceps brachii, GT = greater tuberosity, LT = lesser tuberosity, SS = supraspinatus muscle and tendon BG = bicipital groove.

was grossly flat, and in the coronal plane, the structure had a linear shape. The average measurements of the structure in the first specimen were 52 mm, craniocaudal; 6.7 mm, anteroposterior; and 0.8 mm, mediolateral and in the second specimen were 39 mm, craniocaudal; 5.7 mm, anteroposterior; and 0.9 mm, mediolateral (average, 45.5 mmin craniocaudal, 6.2 mm in anteroposterior, and 0.85 mm in mediolateral dimensions).

Histologically, in both specimens, the structure had architecture indicative of a tendon, and no muscular fibers were identified near the bicipital groove. In both instances, the tendon originated in the greater tuberosity from cortical bone (Fig. 3). The long head of the biceps tendon was clearly separated from the anomalous tendon by a synovial sheath in both specimens (Fig. 4).

Discussion

Accessory heads of the biceps brachii muscle are believed to be among the most common variations of the shoulder and upper aspect of the arm [3, 4]. The biceps brachii muscle is classically described as arising by a long head that originates from supraglenoid tubercle and a short head that originates in the coracoid process; these heads unite in the upper arm and insert through a common tendon or separate tendons into the bicipital tuberosity of the radius, with an aponeurosis (lacertus fibrosus) present at the myotendinous junction [5–10]. The biceps brachii muscle, however, is one of the most variable in the human body in terms of morphology and number of composite heads, especially at the origin of the muscle [11–13].

The prevalence of a supernumerary head varies from 9.1% to 22.9% depending on the ethnic group. It is more common in the Asian population and less frequent in the white population [4, 14]. Reported variations of the bicipital heads include additional origins from the articular capsule of the glenohumeral joint and tuberosities of the humerus, a bifurcated tendon, and the presence of multiple heads with origins from the coracoid process and humerus [5, 15, 16]. Concerning the weight of the accessory heads, in a cadaveric study conducted by Nakatani et al. [16], the body mass of the accessory muscle contributed approximately 10% to the total biceps muscle weight. Another variation that can be found about the shoulder is a modified trajectory of the musculocutaneous nerve, which can pass behind, in front of, or even through the supernumerary head. That fact has great importance at the time of surgical procedures in this region [17].

A further accessory muscle that can be found in this region is the coracobrachialis brevis muscle. The normal coracobrachialis muscle usually arises from the coracoid process of the scapula in common with the tendon of the short head of the biceps brachii

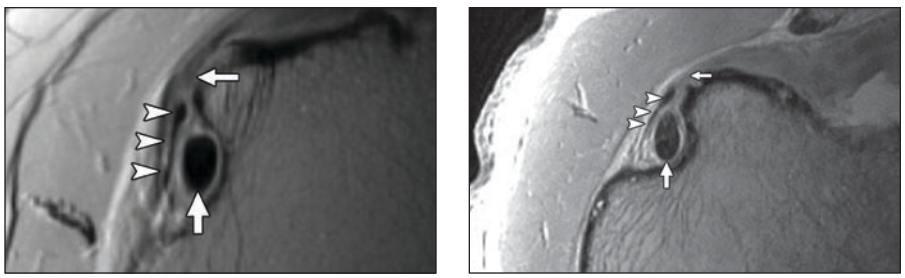


Fig. 2—Specimens from two male cadavers.
A and **B**, MR images in axial plane of two different male specimens (age at death, 91 years [**A**] and 79 years [**B**]) show anomalous tendon (*arrowheads*), long head of biceps tendon (*thick arrows*), and subscapularis tendon (*thin arrows*).

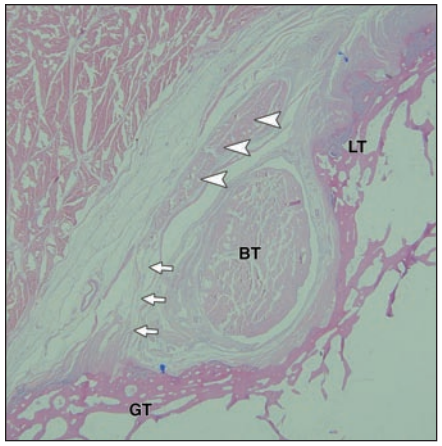
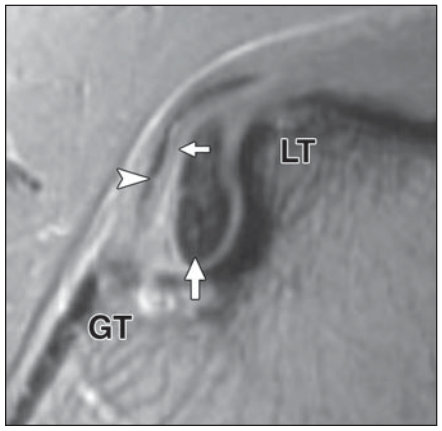
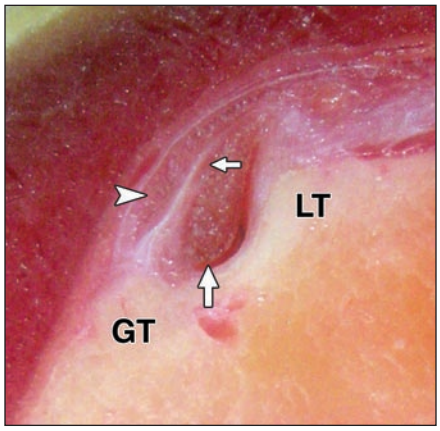


Fig. 3—Histology specimen obtained in axial plane from male cadaver (age 91 years at death) shows bicipital groove, lesser tuberosity (LT), greater tuberosity (GT), long head of biceps tendon (BT), and accessory muscle (*arrowheads*) and its insertion in lesser tuberosity (*arrows*).



A



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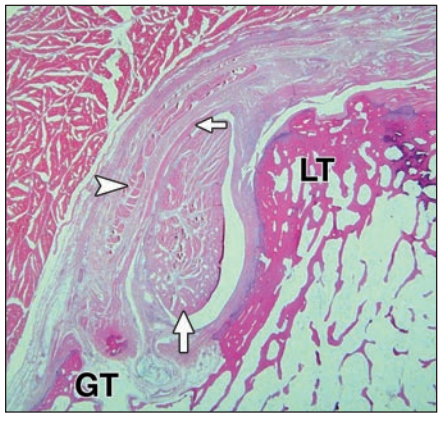

C

Fig. 4—Specimens from male cadaver (age 91 years at death).
A–C, Transverse MR image (**A**), anatomic photograph (**B**), and histology specimen (**C**) at level 2 cm below top of humeral head show accessory head of biceps brachii muscle (*arrowheads*) and long head of biceps tendon (*thick arrows*) and its synovial sheath (*thin arrows*). GT = greater tuberosity, LT = lesser tuberosity.

muscle, and it inserts on the medial aspect of the midshaft of the humerus [18]. The coracobrachialis brevis muscle is considered an anatomic variant that originates from the lower or outer portion of the coracoid process and inserts into the anterior capsule of the glenohumeral joint, inner border of the bicipital groove, and medial aspect of the humeral neck [5, 18–20]. Furthermore, some reports have described other variations of this muscle that include accessory slips that attach to the lesser tuberosity, medial supracondylar ridge, or medial intermuscular septum [21].

In a search for partial tears of the tendon of the biceps brachii muscle within the bicipital groove, axial MR images should be carefully reviewed. The identification of a second structure lying adjacent to the tendon in this location is generally considered a reliable sign of tendon tearing. Our study and other investigations have documented that normal nearby structures in the bicipital groove can simulate longitudinal tearing of the biceps tendon [1, 5, 6, 8, 11]. These structures include lateral circumflex humeral vessels, the transverse ligament, and fibers of the supraspinatus and subscapularis tendons that traverse the bicipital groove [22, 23]. To that list must now be added an accessory head of the biceps brachii muscle, found in 20% of our specimens.

Unlike some anatomic studies with a large number of specimens, our investigation was limited because of the small sample of shoulder specimens, all derived from male donors. Thus, the true frequency and sex distribution of this anomalous head of the biceps brachii muscle cannot be established on the basis of our results. Still, it is clear that such an accessory muscle may be encountered and, if not recognized, can lead to misdiagnosis of a longitudinal tear of the tendon of the long head of the biceps brachii muscle.

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